Darwin's hypothesis. I do not pretend to say how far received theories may be modified by the facts to which I have drawn attention, but I am convinced that the glacial period must be confined to the northern hemisphere, and some other explanation must be sought for our Alpine flora. I may remind the Society, however, that I do not wish to extend my observations further than Australia proper. In New Zealand, Julius Haast has found extensive evidence of glacial action, but the observations are rather too limited for us to conclude anything directly therefrom. A true glacial period in New Zealand would be a puzzling fact, and very difficult to reconcile with what we observe in Australia; but we may find hereafter that even in Europe climatial changes may depend upon physical conditions to which New Zealand has been especially and exceptionally subjected. At any rate there has been no glacial period in Australia—in fact, the continent is now passing through a colder period than any of which we can find evidence in its previous geological history.

ART. XII.—*The Manufacture of Paper from Native Plants.* By J. COSMO NEWBERY, B. Sc., Analyst of the Geological Survey of Victoria.

[Read 8th April, 1867.]

The subject of paper-making from raw materials has been for many years occupying the special attention of manufacturers in Europe and America, in reference to the supposed deficiency for meeting the increased demand for paper, consequent upon the progress of education, and the use of this material in various branches of industry. Hitherto rags have been the great staple upon which paper-makers have depended, and for many reasons they are the best adapted for the manufacture of the finer varieties of paper, they have passed through a thorough cleansing from refuse during their conversion from raw vegetable fibres into woven fabrics, and even the wear and tear to which they have been subjected, renders them particularly well adapted for the purpose. When, however, the manufacturer has to resort to raw material, the whole cost of this cleansing and preparing has to be defrayed by the paper produced. I am of course speaking of the best white rags; when those of an

inferior quality are used, they need much time and labour to fit them for conversion into white paper. It is well known that almost every vegetable fibre may be used in making paper, but though experiments have been made for the past hundred years to find a substitute for rags, only very limited success has attended any of them. In the British Museum there is a collection of sixty specimens of paper made from different materials, the result of one man's experiments in or about the year 1770 ; and the Patent-office reports teem with patents for the use of various fibres, or the method of treating those already proposed. But no fibre has yet been found to make a paper equal to white linen rags. Some on account of their comparatively trifling value, arising from the limited use to which they are otherwise applicable, can be used to mix in various proportions with rags to make the cheaper white papers, such as that used for newspaper, which is now seldom made with more than thirty per cent. of rags. Up to the present date, everything proposed as a perfect substitute for rags has been excluded by the cost of freight or preparation, or by these expenses combined. It is within the last ten years that straw came into use as a partial substitute for rags in poor white papers ; and until lately the difficulty of and expense of removing the silicious coating and other expenses connected with working it, made the paper cost almost as much as pure rag paper. About 1860, esparto, a tough Spanish grass, was introduced into England, and since then into Belgium, and some has even found its way to the United States.

In England this grass has almost wholly superseded straw in white papers, and also to a great extent in brown and wrapping papers. Though in the latter so many articles may be used that it is very difficult to arrive at a correct estimate of the quantity of any one of the components in the brown paper of any country. The best brown papers of England and America consist in a great measure of Manilla hemp derived from waste and worn-out cordage ; and jute fibre, either derived from old bags or waste fibre, shipped direct from Calcutta ; and, as I have mentioned esparto in England, the cost of freight and customs' duty to a great extent preventing its use in America. The amount annually imported into England is about 15,000 tons, and is worth about £6 per ton. Jute is also largely imported, but I have no data as to the amount.

The loss in the manufacture of the articles I have named, are approximately—rags, 30 per cent.; Manilla hemp (clean), for brown paper, 35 per cent.; esparto, 40 per cent.; jute, 40 per cent.; straw, 60 per cent.; which at once shows the value of esparto and jute over straw, and of rags over all. Between jute and esparto it is difficult to judge, but I believe that esparto is preferred for white paper, while jute works much easier into brown.

It was with the idea of finding a substitute for esparto in case paper mills were started here, that towards the close of 1865 I began a series of experiments on grasses growing in the neighbourhood of Melbourne, and have found that Victoria produces many fibrous plants that may be used in the manufacture of paper, a branch of industry which must at some time become an important one to this colony. It is not my intention to give you an account of all the fibrous plants I have examined, as I should then be encroaching too much on the province of our learned member, Dr. Mueller, who has told us through our President that he has found some forty plants which yield a fibre from which paper may be made; but I shall limit myself to calling your attention to two grasses, or more properly, perhaps, sedges.

The *Xerotes Longifolia* and a variety of *Lepidosperma*, which I believe to be extremely well adapted for mixing with rags for a white paper, or alone or with any of the ordinary ingredients for making brown and wrapping papers. These two plants are to be found over almost the whole colony, especially on dry, open, sandy country, such as that between Melbourne and Frankston, where they cover miles, to the exclusion of almost every other plant. In some places the *Xerotes Longifolia* predominates, in others the *Lepidosperma* is in greater quantity; but this is immaterial to the manufacturer, as the treatment is the same for both grasses. On this dry country the plants grow from eighteen inches to two feet in height, but when near water, to a much greater height. I have seen it near the edge of a swamp at Western Port growing to a height of six feet or more, but the fibre in this was much weaker than in the short grass, and the loss in manufacture would be much greater on account of a pithy substance which encircles the fibres, which would be lost while the fibre was being converted into pulp. I have also noticed a considerable difference in strength between samples of the grass gathered at the close of 1865 and that gathered at the end of the past year—that of 1865 being stronger and

finer. The samples compared were taken from a paddock near Malvern. The difference may be accounted for by the difference of rainfall during these two years, and would tend to show that the manufacturer should collect the grasses from the driest localities. As I have stated, these grasses are the best Victorian material for a substitute for esparto that has come under my notice. Under ordinary circumstances the grasses may be collected without pith. The resinous coating is easily got rid of by an alkaline solution, and at the same time the colouring matter is rendered soluble. The per centage of pulp is fully equal to esparto, and the fibre as applied to paper making quite as strong. Another point greatly in their favour is, that they have no other uses and are at present valueless.

It may be interesting to go over the present methods used in converting raw material into paper. The number proposed and patented is very great, but all have one object in view, the destruction of the silicious and resinous coating, which, besides rendering the fibre brittle, protects the colouring matter from the action of the bleaching solution. It has been proposed to crush the fibre between rollers, and then to destroy this coating by means of an acid, either hydrochloric, sulphuric, or nitric may be used. This has been found to answer in the case of sugar-canes, but for materials having a fine fibre it does not answer well, as the acid invariably acts on the fibre, rendering it weak and harsh. Others digest the crushed fibre in vats for from ten to eighteen hours with an alkaline solution heated by steam pipes. This works well with some fibres, but as in the case of the acids, the fibre is to some extent damaged. I believe no method has succeeded so well as that in which the uncrushed material is placed in a rotary high-pressure boiler, with a solution of lime or dilute alkali, after which the aperture is closed and high pressure steam introduced through a pipe passing through the axle upon which the boiler revolves, and the pressure maintained at about 100 lbs. per square inch for from five to fourteen hours. When the fibre is removed from the boiler, the coating is either dissolved or rendered lose so that it may be easily removed in the process of washing in a beating machine, and at the same time the greater part of the colouring matter, which has been rendered soluble by the action of the alkaline solution, is washed away.

The expense of this method is not much greater than when

vats are used, as there is considerable saving in time and in the amount of alkali used; besides which, there is the great advantage of having the coating thoroughly destroyed, and that without the expense of a crushing. When lime is used, the grass fibres are hardly acted upon at all. I don't know whether this method has ever been used with New Zealand flax, I think it might answer, for that material is so readily acted on by an alkali or an acid, that it is impossible to treat it in a vat.

An alkaline solution which had hardly any affect on *Xerotes Longifolia* or *Lepidospermia*, completely destroyed the fibre of the flax. The solution I used contained slightly over one per cent. of caustic soda, and the experiments were conducted in open vessels at a temperature of 212° F., so that the quantity of alkali I used would be in excess of what is required in a high pressure boiler. I am not quite certain of the amount of lime or alkali which would be required per ton of the grasses whose use I have proposed, as it will need experiments on a larger scale than any I have been able to make to fix it definitely.

It has been proposed to treat raw materials without the aid of solutions—first passing them through crushing rollers and packing the crushed material in a strong iron vessel, and then introducing super-heated steam, which is said to act far more effectually and in much less time than the rotary boiler process, but I have only the patentee's statement to go upon. The use of super-heated steam has been patented before, but it has always been introduced into vessels containing alkaline solutions, the patentees forgetting that the steam would give up its extra heat to convert the water present into vapour, and that the concentrated alkaline solution which would be formed, would act most detrimentally upon the fibres. There are other methods of treating raw materials, but no great success has yet attended any of them. There is also the manufacture of paper from wood, which may soon become one of importance, though the paper will never be a strong one.

After one of the processes I have spoken of has been gone through, the fibre is washed and beaten into pulp in wha is termed the pulping-engine; and if for brown paper, it is then coloured and sized as required before passing ont to the Foudeneir machine to be rolled into paper. But if white paper is required, it has to be bleached; this in the case of vegetable fibres takes much longer than in the case of rags,

though the chemicals used are the same, chloride of lime, dilute acid, and weak alkaline solutions. The acid used is usually hydrochloric or sulphuric, which must be very dilute or the fibre will be injured. A process has been patented lately in France for using carbonic acid instead of the stronger acids, which has the advantage of being cheaper, and an excess does not damage the fibre. It is proposed to generate this acid by burning charcoal in a current of air and making it pass up through the vat containing the bleach by introducing it at the bottom by means of a perforated pipe. After the bleaching, the pulp undergoes the same treatment, no matter from what material it is derived.

There seems to be great difficulty in selecting a site for a mill close to Melbourne, as the Yarra, besides being liable to floods, is not sufficiently clear for white paper, and the small streams would not supply sufficient water during the whole year. Few, I think, know that one hundred gallons of water are used in the production of every pound of white paper.

Everyone interested might make experiments testing the value of plants for paper-making, without having any prior knowledge of the manufacture by working thus: Gathering the leaves when they have attained their full size, and drying in the sun, then taking a weighed quantity and mascerate it with water in a mortar, then digest it in a hot solution of lime, or dilute alkali, or strong soap answers very well, as long as the solution is coloured, then wash with hot water, dry and weigh. The result is nearly correct for brown paper, but a little too high for white, on account of the loss which takes place in pulping.

Machinery was brought here by the late Mr. Kenny, who intended to start a manufactory. Since his death this machinery has lain idle, but I think we may hope soon to see it in operation.